FIG. 1
APPARATUS FOR TRANSFERRING A LIQUID FROM ONE CONTAINER TO ANOTHER


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21 Claims

ABSTRACT OF THE DISCLOSURE

Liquid in selected quantities is transferred through a conduit from a container to the operative section of an analytical instrument by applying gas pressure to the surface of the liquid sample. The chamber for coupling the gas pressure to the surface of the liquid is provided with a gas bypass to prevent spraying of the liquid. The gas pressure is directed onto the surface of the conduit to remove any liquid that remains on the conduit after a selected quantity has been transferred to the operative part of the analytical instrument.

DISCLOSURE

This invention relates to apparatus for transferring a liquid from one container to another. More particularly, this invention relates to apparatus for transferring liquid in selected quantities through a conduit from a container to the operative part of an analytical instrument by applying gas pressure to the surface of the liquid.

There are many types of analytical instruments which sample or test liquids. In many such instruments it is desirable or even necessary to transfer the liquid sample from a container into the operative section of the instrument. Such operative section may include by way of example a cuvette as in a spectrophotometer, or an injection nozzle as in a flame photometer, or a gas chromatograph port. Regardless of the type of analytical instrument, the present invention provides a new and improved apparatus for transferring a liquid sample from a container into the operative section of such instrument.

The liquid sample is conducted from its container, which may be a test tube, beaker or the like, to the operative section of the analytical instrument by a conduit which extends from below the surface of the liquid to the operative section. The liquid is forced to flow through the conduit, which may be plastic or glass tubing, by sealing the container and increasing the gas pressure on the surface of the liquid. Processes and apparatus of this type are known and described in several references. See for example U.S. Pat. Nos. 3,718,266, 3,193,559, 3,348,419, 3,308,691, and 3,522,011. Also similar disclosures are set forth in Australian Patent 254,555 published May 2, 1963 and French Pat. 2,058,446 published May 28, 1971. The present invention is an improvement in the liquid transfer apparatus described in such references.

To operate at all, liquid transfer apparatus of the type described herein must position the entrance end of the liquid transfer conduit below the surface of the liquid sample. Whenever a particular container is exhausted, there is a high likelihood that a surface film or drops of sample from that container will adhere to the outer surface of the conduit even if it is made of a hydrophobic material. Such residue could contaminate the sample in the next container unless it is first removed. The present invention provides a means for removing such residue by uniquely using the gas pressure to both force the liquid to flow through the conduit and also to clean the residue from the surface of said conduit.
it need not be described in detail. Rather, it should be regarded as representative of any one of the number of analytical instruments with which the present invention can be used.

The liquid to be charged into either cuvette 12 or cuvette 14 is contained within test tube 18, which is but one of many types of containers which may be used in connection with the present invention. A test tube is chosen by way of example since it is probably the most common type of container for samples. Those skilled in the art will readily recognize that the container for the sample is not limited in any way except that it must be capable of receiving one of the liquid transfer conduits 20 or 22, substantially below the surface of the liquid contained therein. The liquid transfer conduits 20 or 22, shown in FIG. 1 may be made of glass or plastic, as desired, and also may be referred to herein as tubing.

The tubing 20 is connected to the inlet port of cuvette 12. The outlet port of cuvette 12 is connected by tubing 24 to solenoid valve 26. Tubing 22 is connected to the inlet port of cuvette 14. The outlet port of cuvette 14 is connected by tubing 28 to solenoid valve 30. As shown in FIG. 2, valve 26 is connected by tubing 32 to drain 36. In a like manner, tubing 20 extends through the apparatus described hereinafter. Thus, the tubing conductors liquid from the test tube 18 through the cuvettes 12 or 14 to a drain 36 under the control of solenoid valves 26 or 30 and other control apparatus as described hereinafter.

As indicated in FIG. 3, each of the liquid transfer conduits 20 and 22 is supported in substantially vertical or horizontal position relative to the bracket 38 which is adjustably mounted on slide rod 40 fixed to the cabinet structure 42 by top and bottom ends supports 44 and 46. Bracket 38 is adjustably positioned on slide rod 40 by means of thumb screw 48 which is threadedly engaged in bracket 38 and bears against slide rod 40. Adjusting the vertical position of bracket 38 on slide rod 40 controls the penetration of the tubing 20 and 22 into the test tube 18 as explained below.

The test tube 18 is guided into position, with either tubing 20 or tubing 22 inserted therein, by test tube guide 52. Test tube guide 52 is fixed to and depends from head 54 which is slidingly fitted over guide rod 40 as illustrated in FIG. 3. Test tube guide 52 is provided with a pair of V-shaped grooves 56 and 58 whose longitudinal axes extend parallel to the tubing 20 and 22. Test tube 18 is accurately positioned with respect to either tubing 20 or tubing 22 by placing it in either groove 56 or groove 58. The open top of the test tube 18 is closed by either seal 60 or seal 62 on the bottom wall of the head 54. The seals 60 and 62 are preferably made of foam rubber or a foam polymeric substance.

The lowermost portion of test tube guide 52 is determined by adjustable stop 64, which is a collar that can be fixed in position on slide rod 40 by setscrew 66. To obtain the minimum volume in the tubing 20 and tubing 22 when using shorter test tubes, one may adjust stop 64 and cut tubing 20 and tubing 22 flush with the bottom of head 54. Alternatively, the position of bracket 38 can be adjusted by means of thumb screw 50 which extends through slot 80. Adjusting the position of bracket 38 allows different size test tubes to be used by effectively changing the position of the distal end of tubing 20 and tubing 22.

Referring to FIG. 4, the drawings, the tubing 22 is shown passing through plate 70, which extends outwardly from bracket 38. The bottom surface of plate 70 is covered with a material 72 for sealing the opening 74 in head 54. Seal 72 is preferably made of a foam rubber or a foam polymeric material, and it closes opening 74 by engaging circumferential lip 76 extending outwardly from the periphery thereof.

The head 54 defines a chamber 78 into which flows a gas under pressure from a source (not shown) connected to tubing 80. The gas is preferably air supplied by a small compressor. However, other types of gas, such as nitrogen, may be used where air would contaminate the sample being fed to the spectrophotometer 16 or other analytical instrument.

As shown, tubing 22 extends through chamber 78 in spaced relationship with respect to the walls of openings 74 and 82 on opposite sides of the chamber. As indicated in FIG. 4, the air or other gas is continuously supplied to chamber 78 and flows around tubing 22 and through openings 74 and 82 except when test tube 18 is positioned against seal 62 to stop the flow of air from chamber 78 through opening 82. The seal 62 is annular and therefore completely surrounds opening 82. By lifting test tube 18, the test tube guide 52 and hence head 54 is forced to slide upward on slide rod 40 until head 54 comes into abutment with seal 72, which closes opening 74 by engagement with lip 76. With opening 74 sealed and test tube 18 in sealed contact with seal 62 the flow of gas is restricted and pressure builds on the surface of the liquid in test tube 18. This forces the liquid to flow through tubing 22 to cuvette 14.

Referring to FIG. 1, it will be observed that a second chamber 84 is provided in head 54. In a like manner, tubing 82 conducts liquid from chamber 84 to the source of gas pressure. Chamber 84 duplicates chamber 78, but for tubing 20.

The continuous flow of gas into and out of chambers 78 and 84 provides a means for continuously removing any residue of liquid which may adhere to tubing 22 or tubing 20 even though they be made of a hydrophobic material. Thus, the air or other gas flows through opening 82, for example, as the head 54 is lowered to its original position. The flow of the gas through the restricted passageway provided by opening 82 blows the residue back into the test tube from which it originally came. The next sample of liquid from another test tube will not be contaminated by residue remaining on the liquid transfer conduit 22. The opening 88 in chamber 84 has the same effect on tubing 20. For best results, the size of the openings 82 and 88 should be empirically determined.

The continuous flow of gas into and out of chambers 78 and 84 is desirable so as to provide the removal of residue as described above. However, the gas tends to blow or otherwise disturb the surface of the liquid as the test tube is brought into engagement with either seal 60 or seal 62. This is particularly noticeable when the test tube is quite full as it tends to blow liquid out of the test tube. Opening 74 in chamber 78 and opening 86 in chamber 84 provide a bypass for the flow of gas out of the chamber until full pressure for delivery of the liquid into either tubing 22, or tubing 20 is required. Thus, full pressure is not applied to the surface of the liquid until the head 54 is brought into engagement with the seal 72. Tubing 20 and tubing 22 pass through the top and bottom openings in chambers 84 and 78 so that the aforesaid removal of residue occurs as the chamber is displaced along said tubing. The size of opening 74 and 86 in relation to tubing 22 and tubing 20 can be empirically determined.

Referring now to FIG. 6, there is shown a schematic diagram of apparatus for controlling the amount of fluid delivered from a test tube to the operative part of the analytical instrument. The elements shown schematically in FIG. 6 have been identified by the same numerals used in FIGS. 1, 2, 3 and 4. In FIG. 6, a second test tube 18' is shown in scaling relation with seal 69 adjacent chamber 84.

Chamber 78 is connected by tubing 80 to the gas supply through flow control valve 92. In a like manner, chamber 84 is connected through tubing 96 to the gas supply through flow control valve 94. Valves 92 and 94 serve to regulate the amount of gas that flows through the system and also isolate each control section from the other. The amount of pressure in chamber 78 is indicated by gauge 90 and the amount of pressure in chamber 84...
is indicated by gauge 98. Adjustable bleed valve 100 is connected to tubing 80 and provides a means to control pressure in chamber 78 by letting gas escape to the atmosphere to relieve excess pressure. Adjustable bleed valve 101 for valve 100 is provided on the front panel of the apparatus 10. In a like manner, bleed valve 102 in tubing 90 provides a means for controlling pressure in chamber 84 by letting gas escape to atmosphere to relieve excess pressure. An adjustment knob 103 for adjustable bleed valve 101 and a similar valve 104 on the side valve 80.

Pressure switch 104 is connected to tubing 80 and is adjusted to close when the pressure builds up as a result of the scaling of the openings to chamber 78. In a like manner, pressure switch 106 is connected to tubing 90 and is adjusted to close when pressure builds in tubing 90 as a result of the closing of openings to chamber 84. Pressure switch 104 is connected to a source of voltage and, when closed as a result of the build up of pressure in tubing 80, completes a circuit to timer 108 and solenoid 110. In a like manner, pressure switch 106 is connected to a source of voltage and completes a circuit to timer 112 and solenoid 114 when pressure builds up in line 90. Solenoid 110 controls valve 26 and solenoid 114 controls valve 30.

The operation of the apparatus 10 should be apparent from what has been described above. Pressure switch 104, for example, senses the build up of pressure in line 80 when the openings to chamber 78 are closed. Switch 104 is set to close at a lower pressure than the bleed pressure set into valve 120. This activates the timer 108 which controls solenoid 110 and valve 26. When valve 26 is open, the pressure on the surface of the liquid in test tube 124 forces it to flow through conduit 22 into cuvette 14. The previous sample is washed out of cuvette 14 through tubing 28, valve 26 and tubing 32 to drain 36. It is desirable that an excess of liquid flow through cuvette 14 to wash out the previous sample. The adjustment of pressure in chamber 78 by valve 100 and the amount of time valve 26 is opened as controlled by timer 108 determines the amount of sample charged into cuvette 14. Knob 116 on the front panel of the apparatus 10 provides an adjustment for timer 108. Knob 118 provides adjustment for timer 112. The manner of charging liquid from test tube 18 into cuvette 12 need not be described in detail since it is redundant with the manner of charging liquid from test tube 18 into cuvette 14.

The amount of time and the amount of pressure can be determined empirically. Factors which cause them to vary are the inside diameters of tubing 20 and tubing 22; the amount of sample required; the density of the liquid; and the viscosity of the liquid.

As previously indicated, the apparatus 10 may be used with a spectrophotometer. Such a spectrophotometer may include a timer that initiates a command signal to a printer which proceeds to print out the absorbance or concentration reading determined by the spectrophotometer at a given time after the sample has been charged into the cuvette. Thus, the apparatus 10 used with a spectrophotometer having an output printer yields a printed result when a test tube containing a sample is pushed against either seal 60 or seal 62 and the head 54 is lifted up and held against seal 72 for a time slightly in excess of the time in 108 or 112. The system automatically senses when the proper pressure seal has been made by virtue of the setting in valve 100 and pressure switch 104 on the one hand and the setting in valve 102 and pressure switch 106 on the other hand. When a proper pressure seal has been made, the apparatus automatically charges a predetermined amount of sample through a cuvette.

Before referring to FIGS. 5 and 7 and 8 there is shown another embodiment of the present invention wherein the insertion of the liquid transfer conduit below the surface of the liquid within a container is automated.

Referring to FIG. 5; the test tube 120 is mounted in a rack 122 which is advanced sequentially to the delivery position beneath liquid transfer conduit 124 in response to control machinery (not shown). The distal end of test tube 124 is supported in head 126 which defines chamber 128 into which a supply of gas, such as air, is constantly flowing through tubing 130. Tubing 124 is slidable fitted through air seal 132 and extends through an opening 134 in the bottom wall of chamber 128. Tubing 124 is of a lesser diameter than opening 134 so that it extends therethrough in spaced relation to the walls thereof. A seal 136 made of foam rubber on polymeric foam extends around opening 134 to close the mouth of test tube 120.

Test tube 120 is pushed into sealing relation with seal 136 by a lifting mechanism 138 which may take any conventional form, and therefore is shown only schematically. The engagement of the mouth of test tube 120 with seal 136 forms a pressure seal and thus forces liquid from test tube 120 into tubing 124 where it is conveyed to cuvette 140.

Apparatus for moving the distal end of tube 124 below the surface of the liquid in test tube 120 includes a slidable mounted ram 142 supporting an elongated bight in tubing 124. Ram 142 is connected by connecting rod 144 to crank 146. Crank 146 is rotatably driven by motor 148.

Ram 142 reciprocates within a fixed block 143. Block 143 is secured to a fixed support 145. Tubing 124 extends through support 145, block 143, ram 142, again through block 143 into head 126. Tubing 124 is fixed at the interface between the fixed support 145 and the block 143. Therefore, movement of ram 142 causes movement of the distal end of tubing 124 into and out of test tube 120. Fixed block 143 is formed with a solid reaction surface 152 which aids in directing the tubing 124 into test tube 120.

The crank 146 and connecting rod 144 cause the ram 142 to reciprocate back and forth over a distance X indicated by the dotted lines. The distal end of tubing 124 is therefore forced down into the test tube 120. As shown in FIG. 6, a pressure switch may be used to detect a build up of pressure when the mouth of test tube 120 is brought into sealing engagement with seal 136. This can then be used to start a timer and to open solenoid valve 150 to let liquid flow into cuvette 140.

It should be noted that the tubing 124 is looped into ram 142. Thus, movement of the ram 142 over a distance X results in a displacement of the distal end of tubing 124 over a distance 2X.

As illustrated in FIGS. 7 and 8, the ram 142 can support two sets of tubing 124 and 124', each connected to a different cuvette. Structure of the tandem system which is identical to that illustrated in FIG. 5 has been indicated with a prime notation of the same reference numeral for ease of discussion. The rack 122 supports parallel rows of test tubes 120 and 120', Adjacent lifting mechanisms 138 and 138' are provided for lifting the test tubes 120 and 120'.

The tubing 124 and 124' lie within U-shaped grooves 154 and 154' in ram 142. The block 143 is provided with keys 156 and 156' which accommodate the grooves 154 and 154' respectively as ram 142 is moved to the right in FIG. 5 thereby causing the tubing 124 and 124' to enter test tubes 120 and 120', respectively.

It should be noted that the apparatus described herein does not require means to sense the presence of a test tube or other container. If a test tube is not present in a rack a pressure seal is not formed and no sample is charged into a cuvette. The previous sample remains in the cuvette. Thus, the fact that a test tube is not present is a form of test tube sensing and allows a previous sample to remain in a cuvette. This has the advantage of initially charging the reference into one of the cuvettes and allowing it to remain leaving the rack empty. The other rack can carry the sample sequentially into position for charging into the sample cuvette.
It is also to be appreciated that in the apparatus set forth in both embodiments of the present invention the tubing is protected from accidental damage as the test tubes are moved up to the heads. As is apparent, the tubing is retracted during the time and test tubes are moved into operative disposition. Accordingly, damage to the tubing is avoided.

The present invention may be embodied in other specific forms without departing from the spirit or essential attributes thereof and, accordingly, reference should be made to the appended claims, rather than to the foregoing specification as indicating the scope of the invention.

It is claimed:

1. An apparatus for transferring a liquid from one container to another, comprising
   a liquid transfer conduit adapted to extend from below the surface of a liquid in said one container to the other container;
   means to raise the pressure on the surface of a liquid within said one container to force fluid to flow from said container through said conduit to the other container;
   said means to raise the pressure including a chamber mounted for relative displacement along said conduit;
   means to connect said chamber to a source of gas to raise the pressure on the surface of a liquid within said one container;
   an opening in said chamber through which the gas may flow to the surface of a liquid in said one container;
   said conduit extending through said opening in spaced relation thereto whereby said gas flowing past said conduit removes adhered liquid residue from the outer surface of said conduit as said chamber is displaced relative to said conduit; and
   a sealing closure for said one container surrounding said opening on the outer wall of said chamber.

2. An apparatus for transferring a liquid from a container to the operative section of an analytical instrument, comprising
   a liquid transfer conduit adapted to extend from below the surface of a liquid in said container to the operative section of the analytical instrument;
   means to raise the pressure on the surface of a liquid within said container to force fluid to flow from said container through said conduit to the operative section;
   said means to raise the pressure including a chamber mounted for relative displacement along said conduit;
   means to connect said chamber to a source of gas to raise the pressure on the surface of a liquid within said container;
   an opening in said chamber through which the gas may flow to the surface of a liquid in said container;
   said conduit extending through said opening in spaced relation thereto whereby said gas flowing past said conduit removes adhered liquid residue from the outer surface of said conduit as said chamber is displaced relative to said conduit; and
   a sealing closure for said container surrounding said opening on the outer wall of said chamber.

3. Apparatus as set forth in Claim 2 wherein said liquid transfer conduit has a retracted position and an extended position, said conduit in said extended position extending below the surface of a liquid in said container, means for moving said conduit into said extended position after said container is in its desired disposition in the apparatus, said conduit in its retracted position being substantially protected from inadvertent damage.

4. Apparatus as set forth in Claim 2 including a pressure sensing means for sensing the presence of said container and initiating operation of said transfer apparatus.

5. Apparatus as set forth in Claim 4 including a timing means operatively associated with said pressure sensing means, valve means controlled by said pressure sensing means to permit the flow of liquid from said container to said analytical instrument, said timing means being operative to close said valve after a predetermined quantity of liquid has been transferred.

6. An apparatus for transferring a liquid from a container to the operative section of an analytical instrument comprising
   a liquid transfer conduit adapted to extend from below the surface of a liquid in said container to the operative section of the analytical instrument;
   means to raise the pressure on the surface of a liquid within said container to force said liquid to flow from said container through said conduit to the operative section;
   said means to raise the pressure including a chamber mounted for relative displacement along said conduit;
   means to connect said chamber to a source of gas to raise the pressure on the surface of a liquid within said container;
   an opening in said chamber through which the gas may flow to the surface of a liquid in said container;
   said conduit extending through said opening in spaced relation thereto whereby said gas flowing past said conduit removes adhered liquid residue from the outer surface of said conduit as said chamber is displaced relative to said conduit;
   a second opening in said chamber for the passage of gas therethrough;
   a seal for closing said second opening fixed on the axis along which said chamber is displaced whereby said gas pressure is fully applied to the surface of a liquid only when said chamber is brought into operative sealing relation with said seal; and
   said chamber having an outer wall surrounding said opening for providing a sealing closure for said container.

7. Apparatus for transferring a liquid from a container to the operative section of an analytical instrument in accordance with Claim 6 wherein said conduit extends through said second opening in spaced relation thereto.

8. An apparatus for transferring a liquid from a container to the operative section of an analytical instrument comprising
   a liquid transfer conduit adapted to extend from below the surface of a liquid in said container to the operative section of an analytical instrument;
   support structure for one end of said liquid transfer conduit supporting said one end in depending relation thereto;
   means to raise the pressure on the surface of a liquid within said container to force the liquid to flow through said conduit from the container to the operative section;
   said means to raise the pressure including a chamber;
   means mounting said chamber on said support structure for relative displacement along said conduit;
   means to connect said chamber to a source of gas to raise the pressure on the surface of a liquid within said container;
   a first opening in said chamber through which the gas may flow from the chamber to the surface of a liquid in the container;
   a second opening in said chamber through which the gas may flow from said chamber;
   said conduit extending through said first and second openings in said chamber in spaced relation to the walls of said openings whereby said gas flowing past said conduit removes adhered liquid residue from the surface of said conduit as said chamber is displaced relative to said conduit; and
   a sealing closure for said container on an outer wall of said chamber surrounding said first opening.
and a seal for closing said second opening mounted on said support structure in alignment with the axis along which said chamber is displaced whereby said gas pressure is fully applied to the surface of a liquid only when said chamber is brought into operative sealing relation with said seal.

9. Apparatus for transferring a liquid from a container to the operative section of an analytical instrument in accordance with Claim 8 including means to adjustably restrict the amount of displacement of said chamber along said conduit to thereby adjust the depth of penetration of said conduit into said container.

10. An apparatus for transferring a liquid from a container to the operative section of an analytical instrument, comprising
   a liquid transfer conduit adapted to extend from below the surface of a liquid in said container to the operative section of the analytical instrument;
   means to raise the pressure on the surface of a liquid within said container to force fluid to flow from said container through said conduit to the operative section;
   said means to raise the pressure including a chamber mounted for relative displacement along said conduit;
   means to connect said chamber to a source of gas to raise the pressure on the surface of a liquid within said container;
   a first opening in said chamber through which the gas may flow to the surface of a liquid in the container;
   a second opening in said chamber through which the gas may flow from said chamber to reduce the pressure of the gas flowing through the first opening in said chamber;
   a seal for closing said second opening;
   means mounting said seal and said chamber for relative displacement to bring said seal and chamber into operative sealing relation to stop the flow of gas from said second opening and thereby increase the flow of gas through said first opening;
   means to seal said container in communication with said first opening;
   whereby the full flow of gas through said first opening onto the surface of a liquid in said container occurs only after said container is brought into sealing relation with said first opening.

11. Apparatus for transferring a liquid from a container to the operative section of an analytical instrument in accordance with Claim 10 wherein said conduit extends at least through said first opening in said chamber in spaced relation thereto whereby gas flowing past said conduit washes adhered liquid from the surface of said conduit as said chamber is displaced relative to said conduit.

12. An apparatus for transferring a liquid from a container to the operative section of an analytical instrument, comprising
   a liquid transfer conduit for conducting liquid from said container to the operative section of the analytical instrument;
   reciprocating means supporting said conduit for inserting a distal end of said conduit into the container; said reciprocating means supporting a bight section of said conduit whereby the amount of displacement of the distal end of said conduit is twice the amount of displacement of said reciprocating means;
   means to raise the pressure on the surface of a liquid within said container to force fluid to flow from said container through said conduit to the operative section;
   said means to raise pressure including a chamber;
   means to connect said chamber to a source of gas to raise the pressure on the surface of a liquid within said container;
   an opening in said chamber through which the gas may flow to the surface of a liquid in said container;
   said conduit extending through said opening in spaced relation thereto whereby said gas flowing past said conduit removes adhered residue from the outer surface of said conduit as said conduit is removed from said container;
   and a sealing closure for said container surrounding said opening on the outer wall of said chamber.

13. Apparatus as set forth in Claim 12 wherein said reciprocating means includes a ram adapted to reciprocate within a block, said ram being grooved to accommodate said conduit, said block having keys at one end thereof for engaging said grooves as said ram moves beyond said container.

14. Apparatus as set forth in Claim 13 wherein said ram has grooves on opposite sides thereof to accommodate two conduits, means for supporting two containers in said apparatus, one of said conduits cooperating with one of said containers and the other of said conduits cooperating with the other of said containers.

15. A method of transferring a liquid from one container to another comprising the steps of providing a liquid transfer conduit; providing a container having liquid therein; mounting a chamber for reciprocation along the liquid transfer conduit; providing communication between the chamber and the container; introducing a continuous flow of gas into the chamber to raise the pressure on the surface of the liquid in the container; contacting the container with the chamber to provide a sealing engagement therebetween; extending the liquid transfer conduit into the container below the surface of the liquid in the container so that liquid travels to the other container as a result of the pressure applied to the surface of the liquid; and directing the flow of gas past the conduit to remove adhered liquid residue from the outer surface of the conduit as the chamber moves relative to the conduit.

16. A method as set forth in Claim 15 including the steps of providing a pressure sensing device for sensing the presence of a container, associating a timing device with the pressure sensing device to permit liquid to flow from one container to the other for a controlled amount of time.

17. A method as set forth in Claim 16 comprising the steps of providing another opening in the chamber so that gas may escape therefrom thereby avoiding turbulence of the liquid within the container as the chamber and container are moved relatively toward one another, and providing a seal for the other opening during transfer of the liquid from one container to another.

18. A device for transferring a liquid from an opened end container comprising
   a liquid transfer conduit having a downwardly extending liquid-receiving end portion, a support structure, a head thereon having an opening through which the downwardly extending portion of the conduit extends with its outer wall in spaced relation to the inner wall of the opening to provide a restricted passage around the conduit, the head being mounted for relative displacement along the conduit, said conduit means in the head communicating with the restricted passage and adapted to connect the passage to a source of gas under pressure whereby gas flows downwardly through the restricted passage and removes adhering liquid from the outer surface of the first-mentioned conduit, a guide member beneath the head adapted to guide an open-ended container in alignment with said end portion of the first-mentioned conduit, whereby movement of the container along the guide is adapted to
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11. A device according to Claim 10 comprising a seal structure above the head surrounding the restricted passage whereby the gas flowing downward through the restricted passage exerts pressure against the surface of the liquid in the container and forces liquid to be transferred from the container through the first-mentioned conduit.

19. A device according to Claim 18 comprising a seal material mounted in stationary position on the support structure above the head and surrounding the first-mentioned conduit whereby upward movement of the container and head along the conduit brings
(1) the upper end of the restricted passage into sealing engagement with the seal material and
(2) the end of the first-mentioned conduit near to the bottom of the container.

20. A device according to Claim 19 including a pressure sensing means for sensing the presence of said container and initiating operation of said transfer apparatus.

21. A device according to claim 20 including timing means operatively associated with said pressure sensing means, and valve means controlled by said pressure sensing means to permit the flow of liquid from said container, said timing means being operative to close said valve after a predetermined quantity of said liquid has been transferred.

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